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(54) **Image processing method and apparatus.**

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Description

The present invention relates to an image processing method and apparatus particularly for color image processing.

In a color image input/output system such as a color scanner and laser color printer, a density signal for each color read from a color original by using a reader (e.g., color scanner) is subjected to gradation processing and thereafter, supplied to an image output device (e.g., laser color printer). In most cases, the density signal is corrected by using a gradation conversion table so as to obtain a final output image having a visually proper or favorable quality (final output image is an image directly outputted from a laser color printer, or a print obtained from a dot matrix of a color scanner).

Specifically, in a color print system using a color scanner, a scanner head is manually set at a particular point on a scanner drum to check the final dot percent for each color (e.g., yellow, cyan, magenta). If it is determined that a desired final dot percent cannot be obtained, the values in a gradation conversion table are manually corrected upon actuation of an adjusting knob. Alternatively, in a system using a layout scanner, an original is displayed on a graphics display to designate the particular point with a light pen, joy stick or the like and to correct the gradation table in the similar manner as above.

As a method of automatically correcting the gradation table, there is known a method whereby an average value for each color R (red), G (Green), B(Blue), or Y(Yellow), M(magenta), C(Cyan) of image data is obtained to give a bias to the image data (i.e., to perform a parallel displacement of the gradation table). There is also known a method whereby the gradation table is corrected such that the highlight point (with lowest density value or with pixels smaller than a predetermined number) and shadow point (with highest density value or with pixels larger than a predetermined value) of image data take the maximum and minimum value (255 and 0 for 8 bit digital data, respectively).

According to the above conventional methods, the gamma conversion is carried out for each image plane of R, G and B (or Y, M and C) by using the gradation table to thereby obtain a visually fine or favorable image quality. These methods therefore do not consider an automatic correction of color hue. In other words, an automatic masking process is not carried out.

It is therefore a concern of the present invention to provide an image processing method and apparatus capable of obtaining an image with visually favorable quality.

It is another concern of the present invention to provide an image processing method and apparatus capable of reproducing favorable color.

It is a further concern of the present invention to provide an image processing method and apparatus capable of reproducing a fade-out image as an image without fading.

According to one aspect of the present invention there is provided an image processing method as set out in claim 1.

According to a second aspect of the invention there is provided image processing apparatus as set out in claim 7.

Preferred embodiments of the present invention will now be described by way of example and with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram showing the outline of a first embodiment of an image processing apparatus capable of reproducing a visually favorable color.

Fig. 2 is a diagram showing the image memories shown in Fig. 1 and the calculation method for image memory date.

Fig. 3 is a flow chart illustrating the operation of the embodiment shown in Fig. 1.

Fig. 4 shows the data structure of a masking coefficient table in the parameter memory shown in Fig. 1.

Fig. 5 is a block diagram showing the outline of a second embodiment of the image processing apparatus.

Fig. 6 is a flow chart illustrating the operation of the second embodiment shown in Fig. 5.

Fig. 7 shows the data structure of the parameter memory shown in Fig. 5.

Prior to describing the embodiments of the present invention, the results of experiments constituting the background art of this invention will be first described. According to the Evans theory, the integrated value for each R, G, B data of an ordinary color image statistically takes substantially a constant level. This statistical fact is applied to the above-described gamma conversion. The inventor considered if this statistical tendency is present also for color balance. According to the experiments aiming at quantitatively determining the favorable visual perception of image, the following facts were found.

If an average value of differences between maximum and minimum values of pixel data within an R, G and B digital color image for each R, G and B data, falls within a certain range, the image is visually perceived as being favorable. If the average value is larger than the upper limit of the range, the color hue of the image is perceived as being flashy, whereas if the average value is smaller than the lower limit of the range, the image

is perceived as a whole as being faded out.

In the experiments, a photograph was used as an input color image, the density at each pixel of the image within the density range of 0 to 2.0 was A/D converted into 8 bit data, and the average value was calculated. According to the experiments, the average value count about 30 to 40 indicated that the image was visually perceived as being favorable. Images regarded as favorable even if they have the count in excess of this range, are particular images such as spot-lighted scenes at concert, poster images mainly composed of characters and illustrations, and the like. This invention aims at making visually favorable, not such particular images but ordinary images such as general scenes, pictures of crowds, portraits and the like. The average value count 30 to 40 is specific to the characteristics of the equipments used in the experiments, such as spectrum filter characteristics and sensitivity characteristics of the input device, and coloring characteristics of the output device. Therefore, the method is not limited to such average value count, but the value count is dependent upon the apparatus to be used.

According to the preferred embodiments to be described later, there is disclosed an apparatus for automatically performing a masking process, which apparatus comprises means for calculating a difference between maximum and minimum values for each pixel data for three dimensional different image data such as R, G and B data, means for obtaining an average value of the calculated differences; masking process means for mask-processing an image by using an optional coefficient; and means for judging if the average value is within a predetermined range. The invention is applicable to various image processing apparatus while reproducing a visually favorable image. Such image processing apparatus include color image input/output means such as laser color copying machines, print layout systems, image editing apparatus, image data retrieving apparatus, and the like.

The preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

Fig. 1 is a block diagram showing the outline of the first embodiment of the image processing apparatus according to the present invention. With this apparatus, an image read with a CCD scanner is processed to obtain a favorable reproduced color which is outputted to a color laser printer.

Referring to Fig. 1, a control processor (CPU) 1 controls the entirety of the apparatus. A program memory 2 stores therein control programs for CPU 1 and various data. A parameter controller 3 controls a processing unit 5, parameter memory 4, and parameter setting I/O 6 upon an instruction from CPU 1, to thereby perform parameter initialization, setting, comparison and the like necessary for the control to be described later. The parameter setting I/O 6 is connected to a keyboard 20 from which various commands and instructions are inputted, and connected to a CRT 22 for the display of inputted data.

A processor 8 and CPU 1 are interconnected via a CPU bus 24 and an image controller 7. The processor 8 which is the main device in an image processing unit 23, receives image data from one of image memories 11 and 12 selected upon an instruction from CPU 1, or from an image data I/O 15, and processes the received data. The processes executed by the image controller 7 include: four fundamental arithmetic operations, logical operation, max/min operation, respectively for each image memory plane and for arbitrary constants; calculation of a difference between maximum and minimum values for each pixel of R, G and B image data; and conversion of R, G and B image data into other three-dimensional coordinate systems such as HLS or YIQ coordinate system. The operation results by the image controller 7 are returned to the selected one of the image memories 11 and 12.

A masking process means 9 performs a masking process (of obtaining one pixel data from three pixel data at three planes, by using four fundamental arithmetic operations) by using a coefficient α set for three R, G and B planes of the selected image memory 11, 12. The calculated results are written in the selected one of the image memory 11, 12 at an arbitrary plane thereof. This operation will be described more in particular with reference to Fig. 2.

Fig. 2 shows the detailed structure of the image memory 12. In this embodiment, the size of one screen frame is 512 x 512 pixels. The image memory is constructed of three planes which are allocated to R, G and B. Each pixel data R (i, j), G(i, j), B(i, j) are quantized in units of 8 bits (0 to 255). Each R, G, B plane shown in Fig. 2 is processed by using a coefficient α set at masking process means 9, and the processed results are outputted as expressed in the following equations:

$$R'(i,j) = (1.0 + 2 * \alpha) * R(i,j) - \alpha * G(i,j) - \alpha * B(i,j)$$
$$G'(i,j) = -\alpha * R(i,j) + (1.0 + 2 * \alpha) * G(i,j) - \alpha * B(i,j)$$
$$B'(i,j) = -\alpha * R(i,j) - \alpha * G(i,j) + (1.0 + 2 * \alpha) * B(i,j)$$

where $1 <= i, j <= 512$

A cumulative counter 10 counts the sum of pixel data values of a selected plane of the image memories 11 and 12. For example, $\Sigma R(i, j)$ is counted for the R plane shown in Fig. 2. An average value $\Sigma R(i, j)/N$ (N is the total number of pixels) is then calculated.

Fig. 4 shows a table for storing masking coefficients α to be set at masking process means 9. The coefficients α take different values depending upon the dynamic range of an input device and upon the HEIKIN (average) value to be described later. The dynamic range differs for each column in the table, and the HEIKIN value differs for each row in the table. Namely, the dynamic range NOUDO 0 (density) is for a density of 0 to 2.0, NOUDO 1 for 0 to 2.5, and NOUDO 2 for 0 to 3.0. The coefficient values α shown in the table of Fig. 4 are stored by using coded data. The table is included in the parameter memory 4 shown in Fig. 1.

The image data I/O 15 is an interface for the input/output of image data, and is connected to the image input/output devices including in this embodiment a CCD color scanner 18 and color laser printer 19 which are selectively used upon an instruction from CPU 1. The color laser printer 19 itself has a masking process circuit for correcting the coloring characteristics of inputted digital color data.

The image memories 11 and 12 each are constructed of three channel frames (e.g., R, G and B or H, L and S). The image memories 11 and 12 are connected to both CPU bus 24 and video bus 25 so that CPU 1 can access both the image memories 11 and 12. Also, the image data in either of the memories can be processed by the processor 8.

The image memories 11 and 12 are connected via the video bus 25 to look-up tables 13 and 14 of high speed RAMs, respectively. Each look-up table has an address space of 256 x 8 bits. Eight address lines of the look-up table are directly connected to an 8 bit (256 tonal levels) output of the corresponding image memory. The output data lines of the look-up table are connected to the video bus 25. CPU 1 can freely read/write image data from/into the look-up tables 13 and 14 via the image controller 7 and processor 8.

A graphic controller 16 controls a graphics CRT 17 to display image data. The graphic controller 16 selects one of the image memories 11 and 12 in accordance with an instruction from CPU 1, and converts the digital image signal outputted from the corresponding look-up table 13, 14 into an analog video signal to display it on the graphics CRT 17.

CRT 22 is used for notifying an operator of an instruction by displaying on it the set parameter or a parameter setting request.

Fig. 3 is a flow chart illustrating the operation of the embodiment which allows faborable color reproduction, and Fig. 4 shows as described previously the contents of the parameter memory 4. The operation of the image processing apparatus constructed as above will be described with reference to the flow chart shown in Fig. 3.

At step S1, CPU 1 sets the image data I/O 15 at an input device selection mode, and the conditions of the image input device for inputting original image data, in this case, the conditions of the CCD scanner 18, are inputted. This input operation is carried out by displaying the dynamic ranges for the CCD scanner 18 on CRT 22 and notifying an operator of a request to input any one of the displayed dynamic ranges. The inputted dynamic range determines the range of the original image density to be used in processing the original image. The original image data within the determined range are expressed by 8 bit data having 1 to 255 tonal levels. In this embodiment, three dynamic ranges of 0 to 2.0, 0 to 2.5, and 0 to 3.0 are used as described previously. An operator selects one of the dynamic ranges, which is stored as one of the values of NOUDO 0, 1, and 2 in the parameter memory 4.

Upon setting the input conditions of image data, CPU 1 causes the processor 8 to notify, via the image data I/O 15, the CCD scanner 18 of the set conditions. In accordance with the notified conditions, the CCD scanner 18 reads the original image data and stores respective R, G and B components thereof in the image memory 11.

At step S2, the maximum values of pixel data for respective pixel points of three planes (R, G, B) are obtained. First, the pixel data at R or a plane of the image memory 11 are compared with the pixel data at G plane or b plane under control of the processor 8. The larger value thereof is stored in the image memory 12 at a plane. Next, the pixel data at a plane of the image memory 12 are compared with the pixel data at B plane or c plane of the image memory 11 under control of the processor 8. The larger value thereof is stored in the image memory 12 at b, the value stored in the image memory 12 at b plane being the maximum value of pixel data for one pixel point. The maximum values for all pixels are stored in the above manner.

At step S3, the minimum values of pixel data for respective pixel points of three planes (R, G, B) are obtained. First, the pixel data at R or a plane of the image memory 11 are compared with the pixel data at G plane or b plane under control of the processor 8. The smaller value thereof is stored in the image memory 12 at a plane. Next, the pixel data at a plane of the image memory 12 are compared with the pixel data at B plane or c plane of the image memory 11 under control of the processor 8. The smaller value thereof is stored in the image memory 12 at c, the value stored in the image memory 12 at c plane being the minimum value of pixel data for one pixel point. The minimum values for all pixels are stored in the above manner.

At step S4, based upon the pixel data stored at step S2 in the image memory at b plane and the pixel data stored at step S3 in the image memory at c plane, a difference therebetween is obtained for each pixel point

through calculation by the processor 8. The results are written in the image memory 12 at a plane.

At step S5, an average value of the differential pixel data in the image memory 12 at a plane is calculated and stored as the variable HEIKIN. The more detailed operation at step S5 will be given below. upon reception of an instruction from CPU 1 via the image controller 7, the cumulative counter 10 counts the sum of the differential pixel data in the image memory 12 at a plane, to thus obtain $\Sigma X(i, j)$, wherein $X(i, j)$ represents 8 bit data, i, and j are an integer from 1 to 512. The sum is then divided by the total number N ($512 * 512$) of pixels to obtain the average value (variable HEIKIN). The decimal of the average value HEIKIN is cut off to obtain an integer variable which takes one of 0 to 255.

At step S6, in accordance with the obtained variable HEIKIN and the set value NOUDO of the dynamic range of the input device, the masking coefficient α is read from the data table (Fig. 4) in the parameter memory 4, and set at masking process means 9. Specifically, CPU 1 generates an address of the data table in the parameter memory 4 to access the masking coefficient corresponding to the variable HEIKIN and NOUDO value. The read-out masking coefficient is set at masking process means 9 by means of the parameter controller 3 and image controller 7. For example, for the variable HEIKIN of 18 and the dynamic range set value NOUDO of 0 (range from 0 to 2.0), the masking coefficient α of 0.28 is read and set at masking process means 9.

At step S7, masking process is performed by masking process means 9. First, image data are read from the image memory 11 at R, G and B planes to execute the following processes. First, the following calculation is carried out and the results are stored in the image memory 12 at a plane:

$$(1.0 + 2 * \alpha) * R(i,j) - \alpha * G(i,j) - \alpha * B(i,j)$$

Next, the following calculation is carried out and the results are stored in the image memory 12 at b plane.

$$-\alpha * R(i,j) + (1.0 + 2 * \alpha) * G(i,j) - \alpha * B(i,j)$$

Lastly, the following calculation is carried out and the results are stored in the image memory 12 at c plane. Variables i, and j take a value from 1 to 512.

$$-\alpha * R(i,j) - \alpha * G(i,j) + (1.0 + 2 * \alpha) * B(i,j)$$

In the above calculations, if the operation result is an over-flow (in excess of 255), then a value 255 is used, whereas if it is an under-flow (negative value), then a value 0 is used.

At step S8, the image data I/O 15 is switched from the input device selection mode to an output device selection mode, and the processed image data are outputted to the color laser printer via the image data I/O 15. Specifically, the data in the image memory 12 are transferred via the image data I/O 15 to the color laser printer 19 under control of CPU 1. After data transfer, an instruction to output an image is sent to the color printer 19, to complete the image data output.

In the above embodiment, obtaining an average value, generating an address, and setting a parameter are carried out in accordance with a software sequence using a microcomputer. It is obvious however that a dedicated hardware may be used instead to obtain the same advantages of this invention. Further, in the above embodiment, only the masking process has been described in performing a favorable image reproduction. It is obvious however that a conventional technology of gamma conversion may well by used in combination with the masking process.

Various modifications which use the following methods may be made in place of the above embodiment wherein the masking coefficient is obtained by using the dynamic range of an input device and the average value for a plurality of pixels of a difference between the maximum and minimum value for three R, G and B plane data at each individual pixel.

(1) The masking process is carried out by using the following matrix:

$$\begin{pmatrix} R' \\ G' \\ B' \end{pmatrix} \equiv \begin{pmatrix} \alpha 11 & \alpha 12 & \alpha 13 \\ \alpha 21 & \alpha 22 & \alpha 23 \\ \alpha 31 & \alpha 32 & \alpha 33 \end{pmatrix} \cdot \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

where αij, $1 \leqq i, j \leqq 3$

wherein there are provided memory tables the contents of which are read out in accordance with the dynamic range of an input device and the average value of differences for each of three R, G and B planes. According to this method, although a masking coefficient differs more or less depending upon each plane, a masking coefficient specific to a particular plane can be selected. In addition, the calculation such as $(1.0 + 2 * \alpha)$, $(1.0 - \alpha)$ in the above embodiment is not necessary.

(2) Instead of preparing all the masking coefficients for the average values 0 to 255, representative coefficients only are stored in the memory table. A coefficient for each average value is obtained through in-

terpolation, and set at masking process means. For example, instead of preparing all the masking coefficients for the average values 0 to 255 as shown in Fig. 4, masking coefficients for every tenths of average values may be stored in the memory table. The coefficient for an intermediate average value is obtained through interpolation.

(3) In the previous embodiment, a masking coefficient table is prepared due to a difference of dynamic range of an input apparatus, and a coefficient is selected on the basis of both the average value and a value indicative of a dynamic range. However, according to the following method a masking coefficient may be selected by using a memory table including variables of average values only. Namely, an average value of data of a difference between maximum and minimum values for each image pixel in a previous embodiment is divided by a density value (2.0, 2.5 and 3.0) of dynamic range. Then, on the basis of an integer proportional to the value obtained by the division, a masking coefficient is selected with reference to a memory table. In this case, as a matter of course, the memory table corresponds to a table addressable by values obtained by dividing average count values by the density value.

In the above embodiment, as the data at different three dimensional planes of a color image, R, G and B data are used. The method is not limited thereto, but other data such as Y, M and C data, Y, I and Q data, H, L and S data may also be used.

As appreciated from the description of the above embodiment, an operator is not required to designate a particular masking coefficient, but the coefficient is automatically determined in accordance with the image quality to thus allow a visually favorable image output.

Further, the problem of emphasizing the color hue of a negative film more than necessary when outputting it as a positive film can be readily solved. In addition, a fade-out original image can be automatically corrected.

As described so far, according to the image processing method of the embodiment, it is possible to reproduce an image visually favorably.

Next, the second embodiment of the present invention will be described. With this embodiment, the quality of an image to be processed is checked as to whether the quality is required to be corrected. If correction is necessary, the masking coefficient is corrected to obtain a favorable image.

The structure of the apparatus of the second embodiment is shown in Fig. 5 wherein components having similar functions to those shown in Fig. 1 are represented by using identical reference numerals, and the description therefor is omitted.

In this embodiment shown in Fig. 5, different from the embodiment shown in Fig. 1, in addition to the image memories 11 and 12, there are provided an image memory 113 and look-up table 116. The image memory 11 is used for storing original image data, image memory 12 for storing image data after masking processing, and image memory 113 for a work memory during calculation.

Masking process means 9 performs a masking process (of obtaining one pixel data from three pixel data at three planes through four fundamental arithmetic calculations) by using a coefficient α set for three R, G and B planes of an image stored in the image memory 11. The result is written in the image memory 12 at a particular plane thereof.

The structure of the image memories 11, 12 and 113 is the same as shown in Fig. 2. The look-up table 116 has the same structure as that of the look-up table 14, 15.

Fig. 7 shows the contents of a data table stored in the parameter memory 4, the table storing parameters used for incrementing or decrementing the masking coefficient α to be set at masking processing means 9. The coefficient changes with the dynamic range set for an input device.

Specifically, $\Delta\alpha0$ stands for increment values for the masking coefficient associated with the inputted dynamic range of 0 to 2.0, $\Delta\alpha1$ for that of 0 to 2.5, and $\Delta\alpha2$ for that of 0 to 3.0. Namely, the address of the contents to be accessed in the table changes with the dynamic range of an input device.

Description of Process Operation

Fig. 6 is a flow chart showing the operation of reproducing a favorable color according to the second embodiment of this invention.

The operation of the image processing apparatus constructed as above will be described with reference to the flow chart shown in Fig. 6.

At step S1, CPU 1 sets the image data I/O 15 in an input device selection mode, and the conditions of the image input device for inputting original image data, in this case, the conditions of the CCD scanner 18, are inputted. This input operation is carried out by displaying the dynamic ranges for the CCD scanner 18 on CRT 22 and notifying an operator of a request to input any one of the displayed dynamic ranges. The inputted dynamic range determines the range of the original image density to be used in processing the original image. The original image data within the determined range are expressed by 8 bit data having 0 to 255 tonal levels.

In this embodiment, the three dynamic ranges of 0 to 2.0, 0 to 2.5, and 0 to 3.0 are used as described previously. An operator selects one of the dynamic ranges, which is stored as one of the values of NOUDO 0, 1, and 2 in the parameter memory 4.

Upon setting the input conditions of image data, CPU 1 causes the processor 8 to notify, via the image data I/O 15, the CCD scanner 18 of the set conditions. In accordance with the notified conditions, the CCD scanner 18 reads the original image data and stores respective R, G and B components thereon in the image memory 11.

At step S2, CPU 1 initializes the masking coefficient to 0.

At step S3, the masking coefficient initialized at step S2 is set at masking process means 9.

At step S4, the masking process is performed by masking process means 9. First, image data are read from the image memory 11 at R, G and B planes and inputted to masking processing means 9 to execute the masking process. After the masking process, the results are outputted to the image memory 12 whereat the following processes are carried out.

First, the following calculation is carried out for the masking process at R plane, and the results are stored in the image memory 12 at a plane:

$$(1.0 + 2 * \alpha) * R(i,j) - \alpha * G(i,j) - \alpha * B(i,j)$$

Next, the following calculation is carried out for the masking process at G plane, and the results are stored in the image memory 12 at b plane.

$$- \alpha * R(i,j) + (1.0 + 2 * \alpha) * G(i,j) - \alpha * B(i,j)$$

Lastly, the following calculation is carried out for the masking process at B plane, and the results are stored in the image memory 12 at c plane.

$$- \alpha * R(i,j) - \alpha * G(i,j) + (1.0 + 2 * \alpha) * B(i,j)$$

In the above calculations, if the operation result is an over-flow (in excess of 255), then a value 255 is used, whereas if it is an under-flow (negative value), then a value 0 is used.

At step S4 after the initialization of the masking coefficient α=0, the contents 0 of the image memory 11 are simply copied into the image memory 12.

At step S5, the maximum values of pixel data for respective pixel points of three planes (R, G, B) are obtained. First, the pixel data at R or a plane of the image memory 12 are compared with the pixel data at G plane or b plane under control of the processor 8. The larger value thereof is stored in the image memory 13 at a plane. Next, the pixel data at a plane of the image memory 13 are compared with the pixel data at B plane or c plane of the image memory 12 under control of the processor 8. The larger value thereof is stored in the image memory 13 at b, the value stored in the image memory 13 at b plane being the maximum value of pixel data for one pixel point. The maximum values for all pixels are stored in the above manner.

At step S6, the minimum values of pixel data for respective pixel points of three planes (R, G, B) are obtained. First, the pixel data at R or a plane of the image memory 12 are compared with the pixel data at G plane or b plane under control of the processor 8. The smaller value thereof is stored in the image memory 13 at a plane. Next, the pixel data at a plane of the image memory 13 are compared with the pixel data at B plane or c plane of the image memory 12 under control of the processor 8. The smaller value thereof is stored in the image memory 13 at c, the value stored in the image memory 13 at c plane being the minimum value of pixel data for one pixel point. The minimum values for all pixels are stored in the above manner.

At step S7, based upon the pixel data stored at step S5 in the image memory 13 at b plane and the pixel data stored at step S6 in the image memory 13 at c plane, a difference therebetween is obtained for each pixel point through calculation by the processor 8. The results are written in the image memory 13 at a plane.

At step S8, an average value of the differential pixel data in the image memory 13 at a plane is calculated and stored as the variable HEIKIN. The more detailed operation at step S8 will be given below. Upon reception of an instruction from CPU 1 via the image controller 7, the cumulative counter 10 counts the sum of pixel data in the image memory 13 at a plane, to thus obtain $\Sigma X(i, j)$, wherein $X(i, j)$ represents 8 bit data, i, and j are an integer from 1 to 512. The sum is then divided by the total number N (512 x 512) of pixels to obtain an average value (variable HEIKIN). The decimal of the average value HEIKIN is cut off to obtain an integer variable which takes one of 0 to 255. The above operation from step S5 to step S8 are substantially the same as those steps at S2 to S5 shown in Fig. 3.

Next, at step S9, the variable HEIKIN is compared with a predetermined value SETTEI 1 (set value 1) stored previously in the parameter memory 4. If the variable HEIKIN is larger than the value SETTEI 1, the control advances to step S13. The SETTEI value 1 corresponds to color characters or illustrations which are regarded as not requesting favorable color reproduction as in the case of ordinary images. Therefore, the control branches from step S9 to S13 to output image data without masking processing.

At step S10, the HEIKIN is compared with a predetermined value SETTEI 2 (set value 2) stored previously in the parameter memory 4. If the variable HEIKIN is larger than the value SETTEI 2, the control advances to

step S13. The value SETTEI 2 corresponds to monochrome images or image having an extremely small color image portion which are regarded not requesting faborable color reproduction as in the case of ordinary images. Therefore, the control branches from step S9 to S13 to output image data without masking processing. On the contrary, if such an image (monochrome image) is emphasized through the masking process, the effects of color shift of an input device is exaggerated to thus result in a visually unfavorable image.

At steps S11 and S12, it is checked if the variable HEIKIN is larger than a predetermined lower limit value SETTEI 3 or smaller than a predetermined upper limit value SETTEI 4. At step S11, if the variable HEIKIN is smaller than the value SETTEI 3, the coefficient α is incremented to $\alpha = \alpha + \Delta\alpha$ and the control returns to step S3, otherwise the control advances to step S12. The value $\Delta\alpha$ corresponding to the variable NOUDO representative of the dynamic range of the input device is read from the parameter memory 4. At step S12, if the variable HEIKIN is larger than the value SETTEI 4, the coefficient α is decremented to $\alpha = \alpha - \Delta\alpha$ and the control returns to step S3, otherwise the control advances to step S13. Also in this case, the value $\Delta\alpha$ corresponding to the variable NOUDO representative of the dynamic range of the input device is read from the parameter memory 4.

At step S13, the image data I/O 15 is switched from the input device selection mode to an output device selection mode, and the processed image data are outputted to the color laser printer 19 via the image data I/O 15. Specifically, the data in the image memory 12 are transferred via the image data I/O 15 to the color laser printer 19 under control of CPU 1. After data transfer, an instruction to output an image is sent to the color printer 19, to complete the image data output.

In the above embodiment, obtaining an average value, generating an address, and setting a parameter are carried out in accordance with a software sequence using a microcomputer. It is obvious however that a dedicated hardware may be used instead to obtain the same advantages of this invention. In the above embodiment, the masking coefficient is incremented or decremented to set the average value of differences between maximum and minimum values of each pixel within a predetermined range. Other known operations on the masking coefficient may be used so long as the average value is set within the predetermined range.

Further, in the above embodiment, only the masking process has been described in performing a favorable image reproduction. It is obvious however that a conventional technology of gamma conversion may well by used in combination with the masking process. In the embodiment shown in Fig. 5, one of the increment/decrement $\Delta\alpha$ values $\Delta\alpha 0$, $\Delta\alpha 1$ and $\Delta\alpha 2$ is selected for each dynamic range of an input device. However, one increment/decrement value only may be used in the following manner. Specifically, in the similar manner as of the embodiment shown in Fig. 1, valuable $\Delta\alpha$ is set to a value corresponding to a density. For example, an average value of data of a difference between maximum and minimum values for each image pixel in a previous embodiment is divided by density value (2.0, 2.5 and 3.0) of dynamic range. Then, on the basis of an integer proportional to the value obtained by the division, a masking coefficient is selected. In this case, as a matter of course, a value of $\Delta\alpha$ in a parameter memory is set to a value obtained by dividing average count value by density value.

As appreciated from the description of the above embodiment, an operator is not required to designate a particular masking coefficient, but the coefficient is automatically determined in accordance with the image quality, and if a masking correction is necessary, the coefficient is automatically corrected, to thus allow a visually faborable image output.

Further, the problem of emphasizing the color hue of a negative film more than necessary when outputting it as a positive film can be readily solved. In addition, a fade-out original image can be automatically corrected. Furthermore, according to this embodiment, an original of color characters or monochrome images can be processed properly.

As described so far, according to the image processing method of this embodiment, it is possible to reproduce an image visually favorably.

According to the first and second embodiments, the masking coefficient is determined based on an average value of differences between maximum and minimum values of all pixels within a screen image. The masking coefficient may also be determined in such a manner that R, G and B data for each pixel are converted into H, L and S (Hue, Lightness, Saturation) data, an average of S data within a screen image is obtained, and the masking coefficient is determined so as for the S data average to have a predetermined value.

Claims

1. An image processing method comprising:
   inputting (Fig.3; S1) a plurality of color component signals representing a color image;
   performing a calculation (Fig.3; S2-S6) using the plurality of color component signals to determine

a parameter for correcting the color image; and

performing a color correction (Fig.3; S7) on the color image as represented by said signals by using the determined parameter, characterised in that,

said calculation step further comprises:

detecting (Fig.3; S2,S3), for each pixel, a maximum component value and a minimum component value;

calculating (Fig.3; S4), for each pixel, the difference between the maximum component value and the minimum component value; and

determining said parameter utilising the average value (HEIKIN) for a plurality of pixels of said difference which corresponds to the dynamic range between the color components of each individual pixel.

2. A method according to claim 1, wherein said determination step obtains an average value of said differences for a plurality of pixels.

3. A method according to either claim 1 or claim 2, wherein the plurality of color component signals are R, G and B signals.

4. A method according to either claim 1 or claim 2, wherein the plurality of color component signals are Y, M and C signals.

5. A method according to any one of the preceding claims, wherein said color correction is a color correction based on a color correction masking coefficient, and said color correction masking coefficient is determined in accordance with said parameter.

6. A method according to any one of the preceding claims, wherein the plurality of pixels are all the pixels of said image.

7. Image processing apparatus comprising:

means (11,12) for receiving a plurality of color component signals representing a color image;

calculation means (8,9,10) utilising the color component signals to determine a parameter for correcting the color image, and

means (8) for performing a color correction on the color image as represented by said signals by using the determined parameter, the apparatus being characterised in that the calculation means determines, for each pixel, a maximum component value and a minimum component value, and calculates, for each pixel, the difference between the maximum component value and the minimum component value, and determines said parameter utilising the average value (HEIKIN) for a plurality of pixels of said difference which corresponds to the dynamic range between the color components of each individual pixel.

Patentansprüche

1. Bildverarbeitungsverfahren mit:

einem Eingeben (Fig. 3; S1) einer Vielzahl von Farbkomponentensignalen, die ein Farbbild darstellen,

einem Durchführen einer Berechnung (Fig. 3; S2 bis S6) unter Verwendung der Vielzahl von Farbkomponentensignalen zum Bestimmen eines Parameters zum Korrigieren des Farbbildes und

einem Durchführen einer Farbkorrektur (Fig. 3; S7) des durch die Signale dargestellten Farbbildes unter Verwendung des bestimmten Parameters,

dadurch gekennzeichnet, daß der Schritt der Berechnung

ein Erfassen (Fig. 3; S2, S3) eines Höchstkomponentenwertes und eines Mindestkomponentenwertes für jedes Bildelement,

ein Berechnen (Fig. 3; S4) der Differenz zwischen dem Höchstkomponentenwert und dem Mindestkomponentenwert für jedes Bildelement und

ein Bestimmen des Parameters aufweist, der den Durchschnittswert (HEIKIN) für eine Vielzahl von Bildelementen der Differenz verwendet, die dem Dynamikbereich zwischen den Farbkomponenten jedes einzelnen Bildelements entspricht.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** der Schritt des Bestimmens einen Durchschnittswert der Differenzen für eine Vielzahl von Bildelementen erhält.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** die Vielzahl der Farbkomponentensignale R-, G- und B-Signale sind.

4. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** die Vielzahl der Farbkomponentensignale Y-, M- und C-Signale sind.

5. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** die Farbkorrektur eine Farbkorrektur auf Grundlage eines Farbkorrektur-Maskierungskoeffizienten ist, und daß der Farbkorrektur-Maskierungskoeffizient entsprechend dem Parameter bestimmt wird.

6. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** die Vielzahl von Bildelementen sämtliche Bildelemente des Bildes sind.

7. Bildverarbeitungsanordnung mit:

   einer Einrichtung (11, 12) zum Empfangen einer Vielzahl von Farbkomponentensignalen, die ein Farbbild darstellen,

   einer Berechnungseinrichtung (8, 9, 10), die die Farbkomponentensignale zum Bestimmen eines Parameters zum Korrigieren des Farbbildes verwendet, und

   einer Einrichtung (8) zum Durchführen einer Farbkorrektur des durch die Signale dargestellten Farbbildes unter Verwendung des bestimmten Parameters,

   dadurch gekennzeichnet, daß die Berechnungseinrichtung

   einen Höchstkomponentenwert und einen Mindestkomponentenwert für jedes Bildelement bestimmt,

   die Differenz zwischen dem Höchstkomponentenwert und dem Mindestkomponentenwert für jedes Bildelement berechnet und

   den Parameter bestimmt, der den Durchschnittswert (HEIKIN) für eine Vielzahl von Bildelementen der Differenz verwendet, die dem Dynamikbereich zwischen den Farbkomponenten jedes einzelnen Bildelements entspricht.

Revendications

1. Procédé de traitement d'images comprenant: l'introduction (figure 3; S1) d'une pluralité de signaux de composantes de couleur représentant une image en couleur; la réalisation d'un calcul (figure 3; S2-S6) en utilisant la pluralité de signaux de composantes de couleur pour déterminer un paramètre afin de corriger l'image en couleur; et

   la réalisation d'une correction de couleur (figure 3; S7) sur l'image en couleur telle que représentée par lesdits signaux en utilisant le paramètre déterminé, caractérisé en ce que

   ladite étape de calcul comprend en outre:

   la détection (figure 3; S2, S3), pour chaque pixel, d'une valeur de composante maximum et d'une valeur de composante minimum;

   le calcul (figure 3; S4), pour chaque pixel, de la différence entre la valeur de composante maximum et la valeur de composante minimum; et

   la détermination dudit paramètre en utilisant la valeur moyenne (HEIKIN) pour une pluralité de pixels de ladite différence qui correspond à la plage dynamique entre les composantes de couleur de chaque pixel individuel.

2. Procédé selon la revendication 1, dans lequel ladite étape de détermination fournit une valeur moyenne desdites différences pour une pluralité de pixels.

3. Procédé selon l'une de la revendication 1 ou de la revendication 2, dans lequel la pluralité de signaux de composantes de couleur sont des signaux R, G et B.

4. Procédé selon l'une de la revendication 1 ou de la revendication 2, dans lequel la pluralité de signaux de composantes de couleur sont des signaux Y, M et C.

5. Procédé selon l'une quelconque des revendications précédentes, dans lequel ladite correction de couleur est une correction de couleur basée sur un coefficient de masquage de correction de couleur, et ledit coefficient de masquage de correction de couleur est déterminé en fonction dudit paramètre.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel la pluralité de pixels sont tous les pixels de ladite image.

7. Appareil de traitement d'images comprenant:
des moyens (11, 12) pour recevoir une pluralité de signaux de composantes de couleur représentant une image en couleur;
des moyens de calcul (8, 9, 10) utilisant les signaux de composantes de couleur pour déterminer un paramètre afin de corriger l'image en couleur, et
des moyens (8) pour effectuer une correction de couleur sur l'image en couleur telle que représentée par lesdits signaux en utilisant le paramètre déterminé, l'appareil étant caractérisé en ce que les moyens de calcul déterminent, pour chaque pixel, une valeur de composante maximum et une valeur de composante minimum, et calculent, pour chaque pixel, la différence entre la valeur de composante maximum et la valeur de composante minimum, et déterminent ledit paramètre en utilisant la valeur moyenne (HEIKIN) pour une pluralité de pixels de ladite différence qui correspond à la plage dynamique entre les composantes de couleur de chaque pixel individuel.

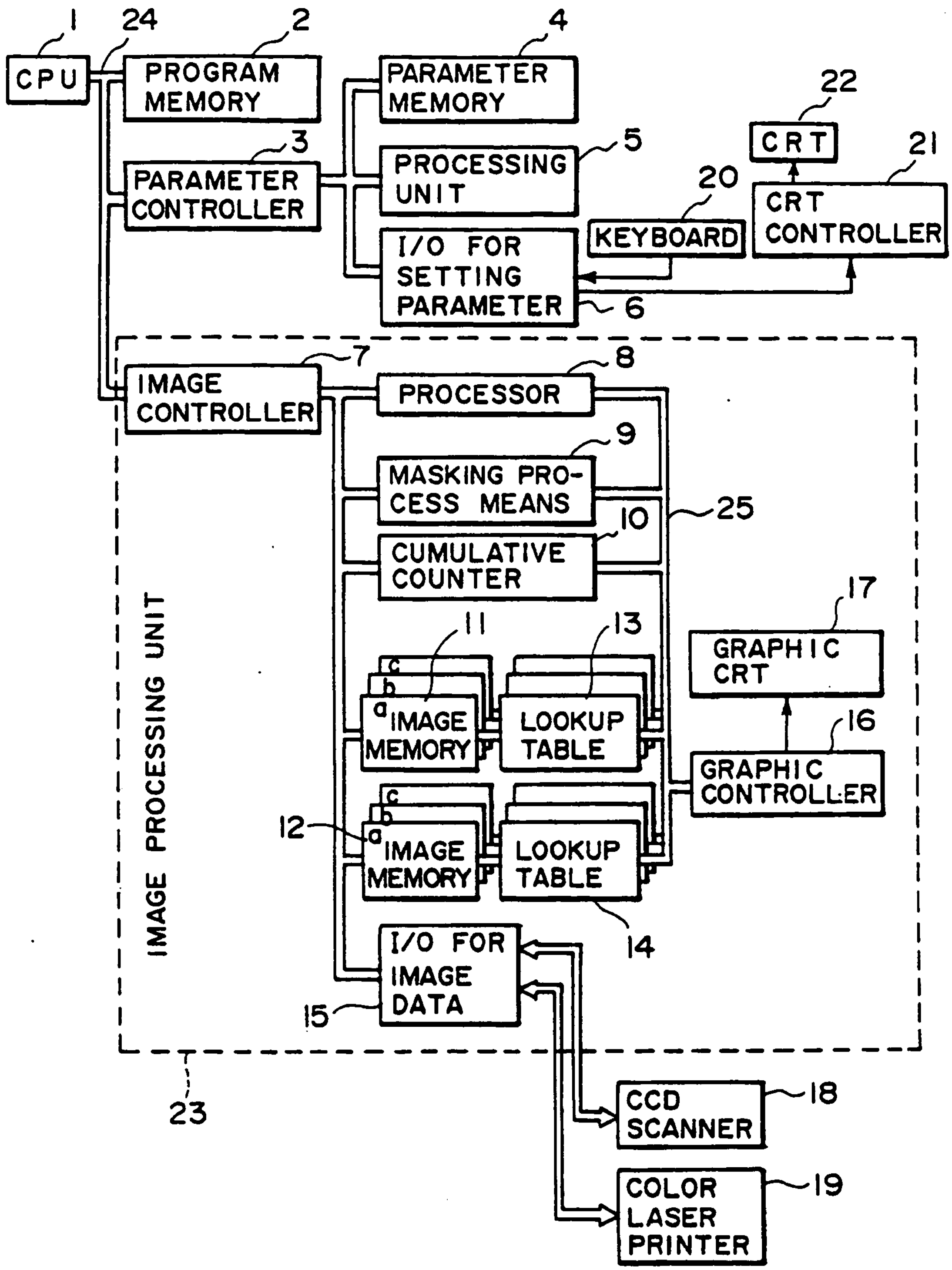

CPU
PROGRAM MEMORY
PARAMETER CONTROLLER
PARAMETER MEMORY
PROCESSING UNIT
I/O FOR SETTING PARAMETER
KEYBOARD
CRT
CRT CONTROLLER
IMAGE PROCESSING UNIT
IMAGE CONTROLLER
PROCESSOR
MASKING PROCESS MEANS
CUMULATIVE COUNTER
IMAGE MEMORY
LOOKUP TABLE
IMAGE MEMORY
LOOKUP TABLE
GRAPHIC CRT
GRAPHIC CONTROLLER
I/O FOR IMAGE DATA
CCD SCANNER
COLOR LASER PRINTER
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

FIG. 1

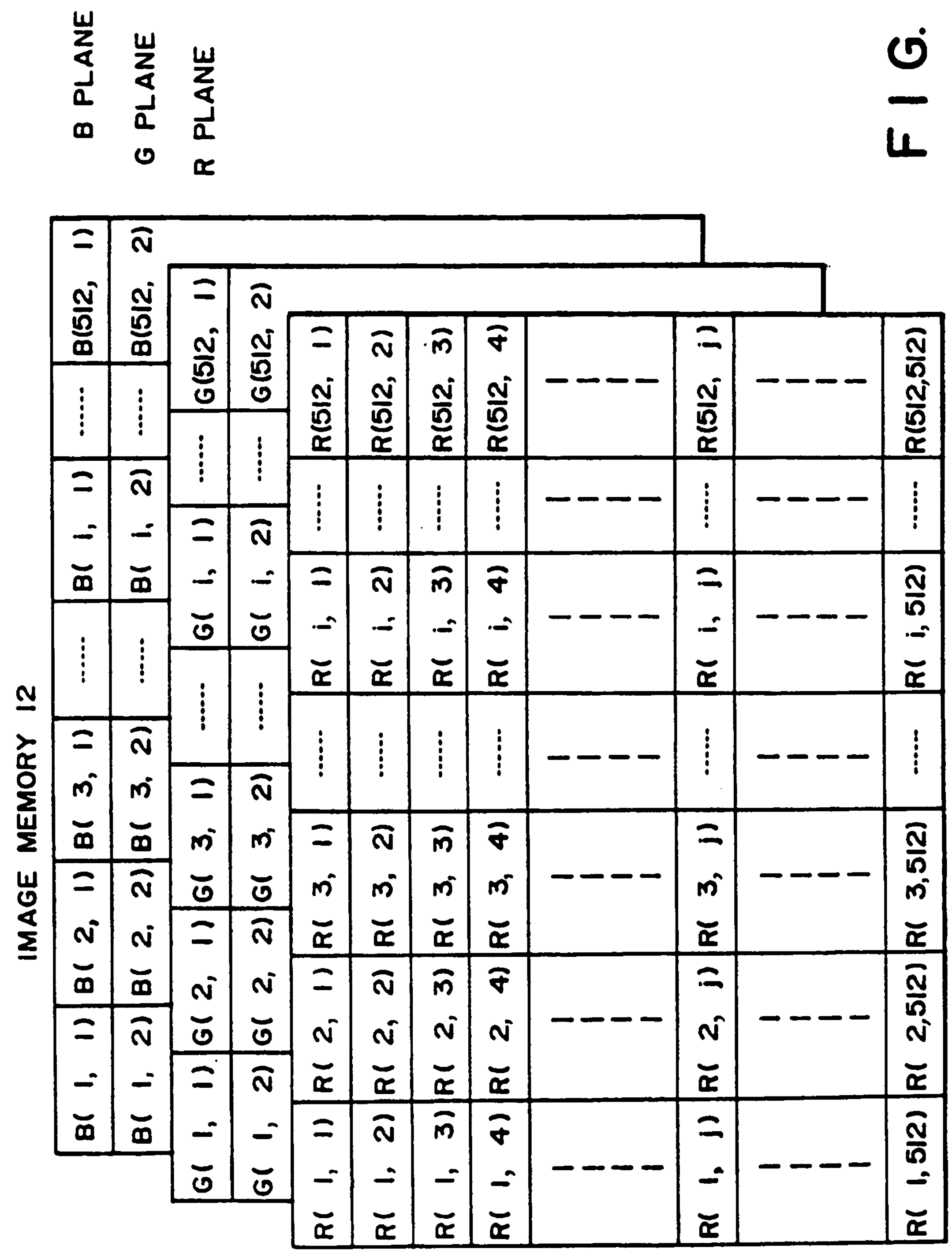


IMAGE MEMORY 12
B PLANE
G PLANE
R PLANE
B(1, 1)
B(2, 1)
B(3, 1)
B(1, 1)
B(512, 1)
B(1, 2)
B(2, 2)
B(3, 2)
B(i, 2)
B(512, 2)
G(1, 1)
G(2, 1)
G(3, 1)
G(i, 1)
G(512, 1)
G(1, 2)
G(2, 2)
G(3, 2)
G(i, 2)
G(512, 2)
R(1, 1)
R(2, 1)
R(3, 1)
R(i, 1)
R(512, 1)
R(1, 2)
R(2, 2)
R(3, 2)
R(i, 2)
R(512, 2)
R(1, 3)
R(2, 3)
R(3, 3)
R(i, 3)
R(512, 3)
R(1, 4)
R(2, 4)
R(3, 4)
R(i, 4)
R(512, 4)
R(1, j)
R(2, j)
R(3, j)
R(i, j)
R(512, j)
R(1,512)
R(2,512)
R(3,512)
R(i,512)
R(512,512)

F I G. 2

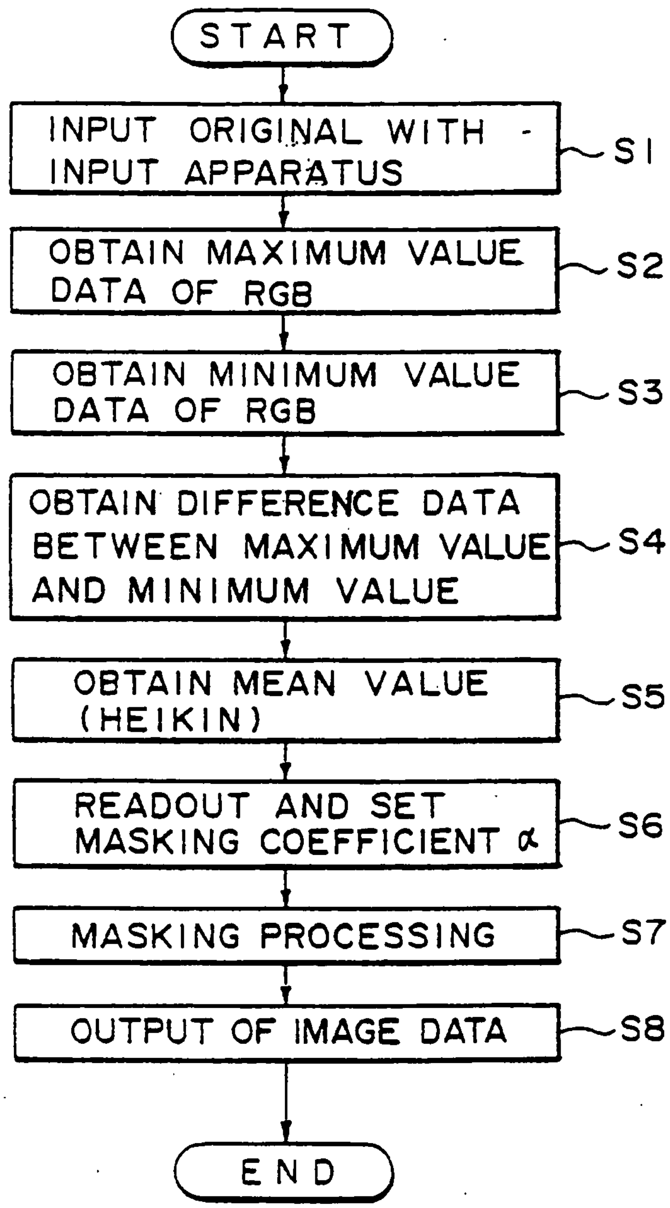

START
INPUT ORIGINAL WITH INPUT APPARATUS
S1
OBTAIN MAXIMUM VALUE DATA OF RGB
S2
OBTAIN MINIMUM VALUE DATA OF RGB
S3
OBTAIN DIFFERENCE DATA BETWEEN MAXIMUM VALUE AND MINIMUM VALUE
S4
OBTAIN MEAN VALUE (HEIKIN)
S5
READOUT AND SET MASKING COEFFICIENT α
S6
MASKING PROCESSING
S7
OUTPUT OF IMAGE DATA
S8
END

FIG. 3

HEIKIN	NOUDO_O	NOUDO_I	NOUDO_3
0	0.0	0.0	0.0
1	0.0	0.0	0.0
2	0.0	0.0	0.0
15	0.0	0.30	0.26
16	0.30	0.28	0.25
17	0.29	0.27	0.24
18	0.28	0.26	0.23
28	0.04	0.02	0.01
29	0.03	0.01	0.00
30	0.02	0.01	0.00
31	0.01	0.00	0.00
32	0.01	0.00	0.00
33	0.00	0.00	0.00
40	0.00	0.00	0.00
41	0.00	0.00	-0.01
42	0.00	0.00	-0.01
43	0.00	-0.01	-0.02
44	-0.01	-0.01	-0.03
45	-0.01	-0.02	-0.04
46	-0.02	-0.03	-0.05
75	-0.30	-0.31	-0.33
76	0.00	0.00	0.00
255	0.00	0.00	0.00

FIG. 4

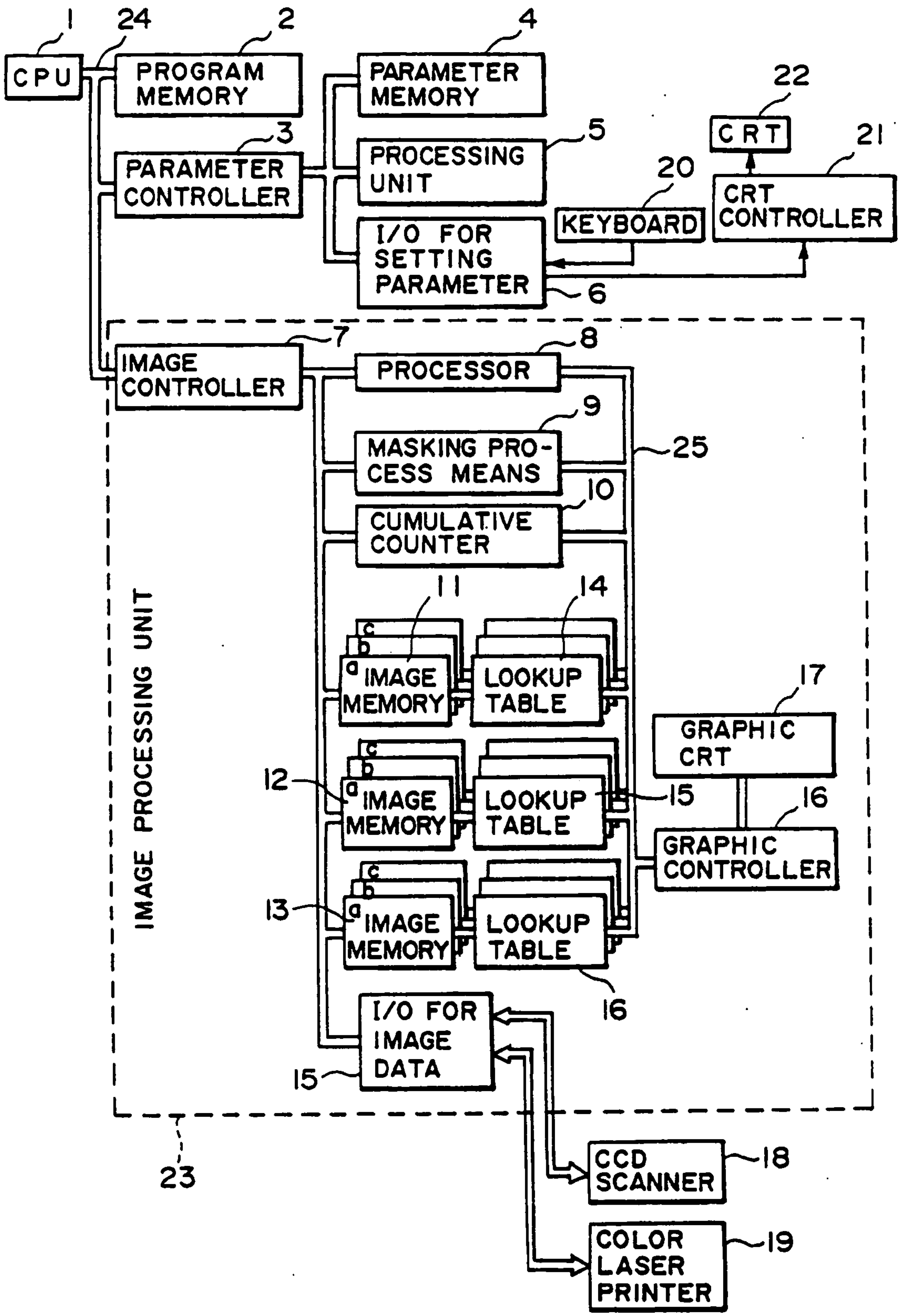
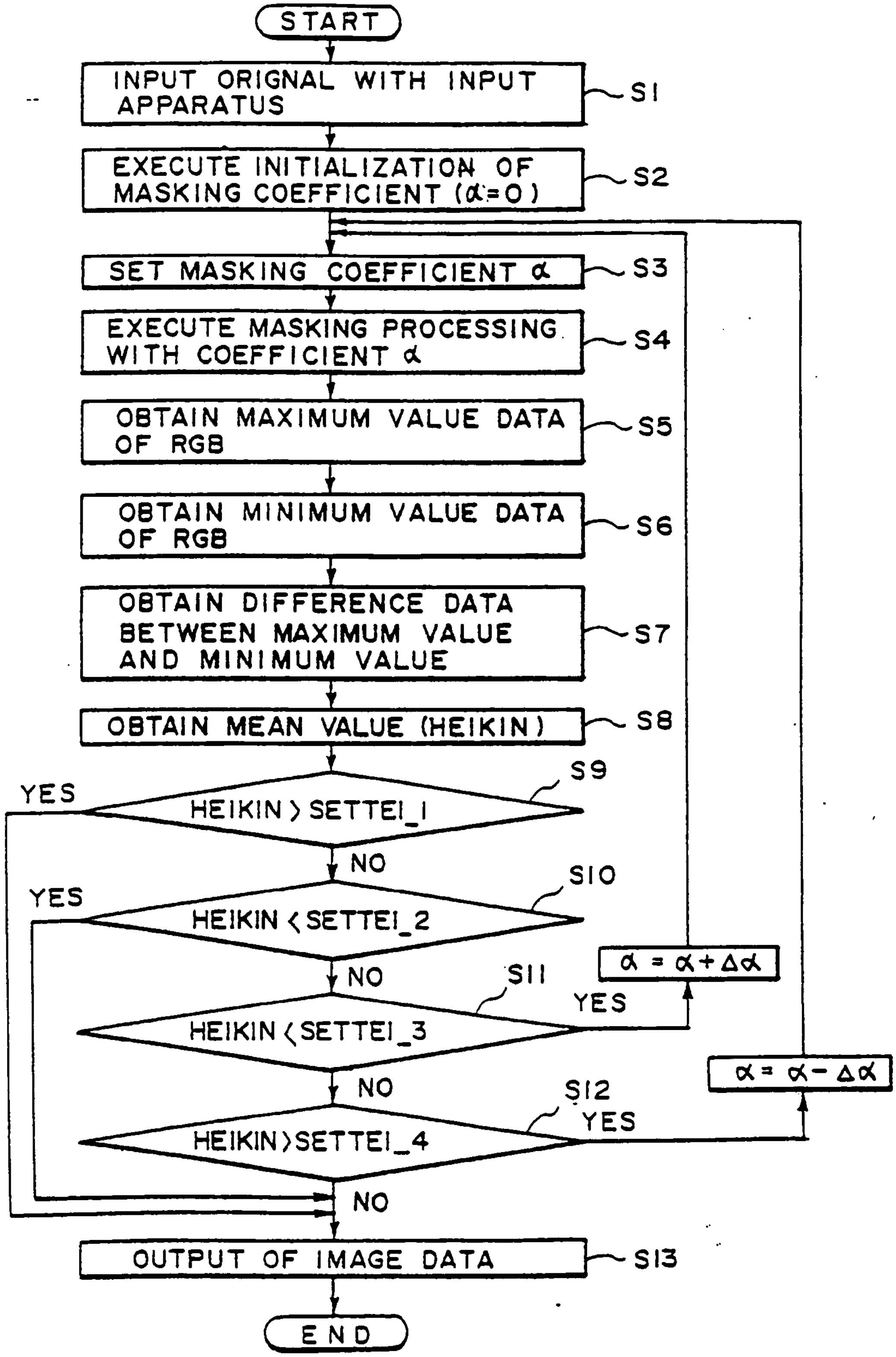

CPU
1
24
PROGRAM MEMORY
2
PARAMETER MEMORY
4
PARAMETER CONTROLLER
3
PROCESSING UNIT
5
I/O FOR SETTING PARAMETER
6
KEYBOARD
20
CRT
22
CRT CONTROLLER
21
IMAGE CONTROLLER
7
PROCESSOR
8
MASKING PROCESS MEANS
9
CUMULATIVE COUNTER
10
25
IMAGE PROCESSING UNIT
IMAGE MEMORY
11
LOOKUP TABLE
14
IMAGE MEMORY
12
LOOKUP TABLE
15
IMAGE MEMORY
13
LOOKUP TABLE
16
GRAPHIC CRT
17
GRAPHIC CONTROLLER
16
I/O FOR IMAGE DATA
15
23
CCD SCANNER
18
COLOR LASER PRINTER
19

FIG. 5


START
INPUT ORIGNAL WITH INPUT APPARATUS
S1
EXECUTE INITIALIZATION OF MASKING COEFFICIENT (α=0)
S2
SET MASKING COEFFICIENT α
S3
EXECUTE MASKING PROCESSING WITH COEFFICIENT α
S4
OBTAIN MAXIMUM VALUE DATA OF RGB
S5
OBTAIN MINIMUM VALUE DATA OF RGB
S6
OBTAIN DIFFERENCE DATA BETWEEN MAXIMUM VALUE AND MINIMUM VALUE
S7
OBTAIN MEAN VALUE (HEIKIN)
S8
S9
YES
HEIKIN > SETTEI_1
NO
S10
YES
HEIKIN < SETTEI_2
NO
α = α+Δα
S11
YES
HEIKIN < SETTEI_3
NO
α = α−Δα
S12
YES
HEIKIN > SETTEI_4
NO
OUTPUT OF IMAGE DATA
S13
END

F I G. 6

PARAMETER MEMORY
NOUDO
SETTEI_1
SETTEI_2
SETTEI_3
SETTEI_4
INITIAL VALUE OF α
$\Delta\alpha 0$
$\Delta\alpha 1$
$\Delta\alpha 2$

FIG. 7